A Comparison of the Loop and Point Methods of Analyzing Vegetation

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During recent years much contorversy has existed among technicians concerning the use of different methods in analyzing vegetation cover. These methods have been developed to minimize personal error and cost of application . However, it appears that many have minimized cost of operation at the expense of accuracy and others have over-emphasized accuracy. A method suitable to measure some characteristics of vegetation may be totally inadequate to measure others. Therefore, the method must frequently be modified to obtain maximum accuracy with reasonable cost.

In the present study, vegetation analysis was made by 3 methods including the line loop transect, the line point transect, and the point frame transect. The purpose of the study was to determine the relative merits of the 3 methods in detemining percent canopy cover, surface ground cover, and floral composition of a mountain brush type. The study area was a mountain brush type in northern Utah consisting mainly of sagebrush (*Artemisia tridentata*) and snowberry (*Symphoricarpos vaccinoides*) with an understory of numerous grasses and forbes (Figure 1).

Review of Literature

Several studies have been made comparing the variations in use of the point contact method. Winkworth (1955) in Australia found that errors caused by thickness of points were significant only in certain types of vegetation. However, he found in general the thicker the point, the higher the apparent percent plant cover. Parker (1951) in working with the loop method found that enlarging the point contact area to as much as ¾ of an inch reduced personal error compared to smaller points. Johnston (1957) in Canada compared the line intercept, the point frame, and the loop method for determining cover. He concluded that the loop method was most rapid but detected fewer species and gave the most variable results. The point frame method gave the least variable data and in general was the most satisfactory.

In a study in Idaho on desert vegetation, sharp (1954) reported close agreement among men using the loop transect to determine plant cover. From 61 to 79 percent of the hits were identical when resets were made on the same transects.

In Nevada, Kinsinger, *et al.* (1959) studied the reliability of the line intercept, the variable plot, and the loop methods in measuring shrub crown cover. They found that the loop method indicated a significantly larger percentage crown cover than the actual amount present. A similar study in California (Heady *et al.* 1959) showed that the line point method (in this study the point of a ¾ inch diameter plumb bob) sampled dominant species satisfactorily but was inferior to the line intercept in sampling minor species.

Hutchings *et al.* (1959) used the ¾ inch loop to represent a plot with area and recorded the presence or absence of a plant when any portion appeared within the loop. The authors stated that a positive bias was introduced because the ¾ inch area included plants or parts of plants that would be missed by a point at the center of the loop.

Procedure

During August of 1959, data were collected by the three methods to determine percent canopy cover, percent surface ground cover, and percent vegetation composition. The study area was 1300 feet long and 500 feet wide. Across the length of the area were located 12 possible grid lines 100 feet apart. Six of these were selected at random for sampling. Along each of these grid lines, two 100-foot sampling transects were chosen at random.

The line point transect method consisted of a pointed rod projected downward at each 1-foot interval along a transect line. The actual point was the tapered end of a ⅛-inch welding rod 36 inches long. The point frame consisted of 10 points mounted on a frame with the points 6 inches apart (Figure 1). The frame was read at 10-foot intervals along a 100-foot tape, making 100 point readings along the transect line. The line loop method is sometimes referred to as a modified line point transect because the small loop may be considered a point. In the present study, a hit was recorded only when ½ or more of a ¾-inch loop was filled. This has been termed a rated loop procedure by Hutchings *et al.* (1959). This procedure reduces the number of hits compared to one which records a species when any of its growth appears within the circle.

At each foot along the 100-foot transect a ¾-inch diameter loop welded to an ⅛-inch diameter rod 36 inches long was projected to the ground surface. Only the uppormost canopy hit was recorded. All other hits were ignored until the loop reached the ground surface or hit the basal crown of a plant. Here records were made on basal crown, litter, bare ground, or rock, whichever made up one-half or more

FIGURE 1. Point frame method being used in a sagebrush-snowberry type to determine canopy and surface ground cover.

of the loop. Herbage on the ground surface was recorded as litter. From these recordings, surface ground cover was determined.

The line loop readings were made at each 1-foot interval along each of 12, 100-foot transect lines. The line point readings were made on only the first 50 feet of each transect to compare with the first 50 readings on the line loop transects and the point frame. The point frame readings were made on alternate 5-foot intervals along all 12 of the transects making a total of 100 points, 6 inches apart, on each 100-foot transect.

On each of the 12 transect lines a reset or a replacement of the line was made about 3 days after the original readings were made. The first 20, 1-foot intervals and the last 20, 1-foot intervals were re-read on each transect to compare with the original readings. The line was reset by use of plumb bobs over steel stakes set at 1½ feet and 98½ feet at the time of the original reading. No reference was made of the recorded first reading during the process of recording the second reading.

Results and Discussion

Comparison of Methods

The line loop transect was compared to the line point transect by reading the first 50 feet on each of 12 transects by both methods by two recorders. As noted in Table 1, recorder "A" obtained a higher percentage canopy cover than recorder "B" by the line point transect but recorder "B" obtained a higher canopy cover by the line loop transect than recorder "A". This interaction between recorders and methods for canopy cover was significant (P>.05). The average percent canopy cover was 44.5 by the line loop transect and 61.4 by the line point method (Table 1). This difference was highly significant (P>.01). Recorder "A" had 71 percent identical hits by both methods and recorder "B" had 78 percent. Thus the two methods were in agreement only about 75 percent of the time. Therefore the 25 percent disagreement contributed to error between the methods.

There were no significant differences between recorders or methods for surface ground cover determinations.

The individual recorders each had several years experience at reading line loop transects in numerous modifications but it was the first attempt for both at interpreting the line point transect. Inexperience could have contributed to the error among methods but recorders checked before and during the study for uniformity of interpretation. At no time was vegetation along the line disturbed by the recorders and therefore this was not believed a factor causing differences between methods or recorders. Some methods were read first on some transects and last on others. Likewise recorder "A" read some transects first and on others recorder "B" read them first.

Table 1. A comparison of two observers using two methods to determine percent canopy and ground cover on twelve 50-foot transects.

	Recorder A				Recorder B			
	Line loop		Line point		Line loop		Line point	
Transects	Canopy	Ground	Canopy	Ground	Canopy	Ground	Canopy	Ground
1	52	92	82	96	56	84	74	90
2	26	74	52	78	36	76	28	74
3	40	88	76	92	60	86	76	92
4	42	76	60	78	36	80	56	90
5	46	74	60	76	30	66	32	80
6	30	70	58	72	28	68	38	86
7	44	90	58	92	48	90	58	90
8	42	88	68	96	64	94	72	98
9	36	88	62	90	46	88	62	92
10	48	88	80	88	54	90	58	88
11	40	86	64	90	52	92	60	94
12	60	94	72	88	52	94	66	98
Averages	42	84	66	86	47	84	57	89

A comparison between the point frame and the line loop methods, using 1200 hits from the 12 transects, showed that the point frame gave a significantly higher percentage canopy cover ($P>.05$) than the line loop transects. These readings were 70.7 and 56.2, respectively.

The point frame gave a slightly higher estimate of ground cover (89 percent) than the line loop transect (84 percent). This difference was not statistically significant. No discernible difference was observed between men when using the point frame method.

The percent floral composition measured by the point frame and the line loop transect differed widely. The point frame gave considerably higher percentages of most grass species whereas the line loop method gave somewhat higher percentages of most browse species (Table 2). No consistent difference was observed for forbs between the two methods. The higher figures for browse for the line loop method are understandable since the browse foliage was considerably more dense and taller and when it was hit, it was more apt to cover one-half or more of the ¾ inch lop whereas, in the case of grasses, a greater number of leaves and stems were required to fill one-half of the loop for a hit. The broad leaved forbs, for the most part, were not densely foliated hence the foliage appearing under the loop did not yield any more hits by

Table 2. Percent composition based upon point hits by 5 different procedures.

Scientific name	Common name	Point frame	Line loop	Basal stem[1]	Plant center[2]	Nearest foliage[3]
Browse				(Percent)		
Amelanchier alnifolia	Service berry	1.18	.15	.09	.09	.52
Artemisia tridentata	Big sagebrush	28.29	35.10	24.16	23.57	27.14
Chrysothamnus lanceolotus	Rabbitbrush	1.42	2.10	1.41	1.42	1.47
Chrysothamnus viscidiflorus	Rabbitbrush	.12	.52	.45	.45	.66
Juniperus osteosperma	Juniper	....	.22	.14	.14	.26
Prunus virginiana	Chokecherry	.35	.52	.34	.34	.36
Purshia tridentata	Bitterbrush	14.61	18.20	12.85	12.31	16.33
Rosa spp.	Rose	.35	.59	.39	.39	.52
Symphoricarpos spp.	Snowberry	10.97	12.10	8.37	8.41	11.91
Average		57.29	69.50	48.20	47.12	59.17
Forbs						
Achillea lanulosa	Yarrow	.83	.74	.59	.59	.52
Aster spp.	Aster	5.66	6.00	17.20	17.17	9.94
Comandra umbellata	Bastard toadflax	2.48	2.10	2.83	2.84	1.97
Eriogonum heracleoides	Wild buckwheat	5.54	5.90	7.31	7.34	6.76
Geranium fremonti	Storkbill	6.96	4.30	3.89	3.91	3.69
Lithospermum ruderale	Ivory seeded borage	.24	....	....	....	....
Lupinus caudatus	Lupine	4.25	4.40	2.95	2.96	3.69
Mahonia repens	Oregon grape	.12	....	.09	.09	....
Polygonum douglasii	Knotweed	....	.07	.05	.05	.05
Potentilla gracilis	Five finger	.12	.15	.29	.30	.10
Average		26.08	23.66	35.20	35.25	26.72
Grasses						
Agropyron inerme	Beardless wheatgrass	2.83	.89	2.36	2.49	1.23
Agropyron trachycaulum	Slender wheatgrass	.07	....	.68	.69	.21
Bromus carinatus	Mountain brome	.05	.07	.14	.14	.05
Carex spp.	Sedge	.60	....	.79	.79	.52
Elymus cinerus	Basin wildrye	.35	.37	.25	.25	.36
Koeleria cristata	Junegrass	.35	.15	.20	.20	.10
Melica bulbosa	Oniongrass	....	....	.09	.09	.10
Poa pratensis	Kentucky bluegrass	8.73	4.40	9.07	9.83	6.85
Sitanion hystrix	Squirreltail	....	....	.09	.09	....
Stipa columbiana	Columbia needlegrass	1.06	.22	.34	.34	.76
Stipa lettermani	Letterman needlegrass	2.59	.74	2.59	2.72	3.93
Average		16.73	6.84	16.60	17.63	14.11

[1] Composition based upon line loop and measuring nearest plant located by nearest basal stem when no hit occurred on the line.

[2] Composition based upon line loop and measuring nearest plant located by nearest center of plant when no hit occurred on the line.

[3] Composition based upon line loop and measuring nearest plant located by nearest foilage hit when no hit occurred on the line.

the line loop than by the point frame. The same differences were noted when comparing the line point transect with the line loop transect. The line point transect analysis of floral composition was not included in Table 2 because only one-half of each transect or one-half the total number of possible points were recorded by this method.

Nearest Plant in Line Loop Transect

To obtain a better estimate of floral composition from a given number of transects, it has been suggested that, when no direct herbage hit occurs on the line, the nearest plant be recorded (Parker 1953). In the present study, the nearest plant in the forward right-hand quadrant or quarter of a circle was recorded. This entailed considering an imaginary line at right angles and to the right side of the tape at the foot interval mark where no hit occurred, thus, outlining the area where the nearest plant must appear. By moving a rod projected downward near the ground level in a quarter circle motion with increased radii lengths from the line the nearest plant was located.

The nearest plant was selected by 3 different procedures; (1) by locating the nearest basal stem of an individual plant about 1 inch above ground level, (2) by locating the plant with its basal crown centered nearest the line, and (3) by locating the plant with the neartest foliage anywhere in the quadrant.

The percent floral compositions based upon canopy hits by the point frame and the line loop transects were compared to the line loop transect supplemented by nearest plant selections by each of the 3 procedures previously described (Table 2). Each of two recorders measured one-half of each transect by each method.

The percent species composition varied widely among the 3 procedures for selecting the nearest plant. When the nearest plant was selected on the basis of the nearest basal stem or the nearest plant center, the forbs and grasses that grew underneath the shrubs were more frequently recorded than the browse overstory. The cover of grasses and forbs increased about 10 and 11 percent, respectively, over the original loop method and shrubs decreased about 21 percent (Table 2).

The selection of the nearest plant by means of the nearest foliage compared favorably with the composition obtained by the point frame method, however, the variability was greater than the point frame. The coefficient of variation for the 5 procedures of determining percent composition of the dominant species was smallest for the point frame method. Thus, the percent species composition based upon canopy hits was most precisely obtained by direct canopy hits along the line transect with the point frame. Theoretically, if the point is a true point and the points are selected at random, then a true estimate of canopy cover and species composition based upon canopy cover can be obtained. However, when the nearest plant procedure is used, there is likelihood of biasing the data. If canopy cover is being measured, selecting the nearest plant by means of nearest basal stem or nearest center of plant introduces bias. In most cases, it is better to increase the point hits by increasing the number of transects. This is true for all determinations where the point hit is used as a datum for estimating canopy cover, basal cover, or species composition.

Table 3. Percent floral composition from the original transect and a reset 3 days later based upon 40 readings in each of 11 transects.

Common name	Line loop original	Line loop[1] reset
	(Percent)	
Browse		
Serviceberry	.41	.38
Big sagebrush	34.98	34.08
Rabbitbrush	2.47	.76
Rabbitbrush	.82	1.52
Chokecherry	1.65	1.52
Bitterbrush	17.70	18.55
Rose	1.65	1.14
Snowberry	9.46	9.09
Average	69.14	67.04
Forbs		
Yarrow	.82	.38
Aster	6.58	8.71
Bastard toadflax	2.06	2.65
Wild buckwheat	4.94	4.17
Stockbill	4.53	5.30
Lupine	2.47	2.65
Five finger	.41	.38
Average	21.81	24.24
Grasses		
Beardless wheatgrass	....	.38
Basin wildrye	.82	.76
Junegrass	.41	.38
Kentucky bluegrass	7.00	6.06
Columbus needlegrass	.41	....
Letterman needlegrass	.41	1.14
Average	9.05	8.72

[1]31.6 percent of the total canpoy hits on the line loop resets were not identical species hits. By an analysis of variance, this difference was highly significant.

Line Loop Transect Resets

In each of 12 transects, the 100-foot steel tape was replaced and re-read by the line loop procedure used in the original reading. One reset recording was lost, therefore Table 3 represents averages from only 11 transects. Canopy cover, ground cover, and percent floral composition based upon canopy cover varied only slightly between the original reading and the reading on the reset. The difference in canopy cover was only 2.5 percent and in ground cover only 1.8 percent.

It should be stated, however, that 31.6 percent of the total canopy hits on the reset line were not identical hits compared to the original readings. Even though about one-third of the hits were not identified with the same plants previously hit on the original transects, the percent canopy cover, surface ground cover, or species composition was not significantly different between the readings. This would be expected since the differences between readings and re-readings were relatively small compared to the variability among all transects in the study.

If each point on each transect is considered a paired reading with the same point on the reset transect, identical hits are of seemingly great importance. In this case, each hit that is not identical, even though it is recorded only a few hours or a few days apart, indicates a change in habitat conditions. The data from this study indicate that a 32 percent change could possibly take place from error in sampling paired points along 11 transects without any actual change in vegetation composition. However, these 32 hits on the reset transect that are not identical with the original hits are still sampling the normal cover of vegetation. Therefore, when a species hit does not agree at one point, it may be compensated for at another point where identical hits did not occur. Therefore, the 2 readings at each point should not be considered as paired readings but rather as separate single readings on almost the same transect.

It is generally agreed that use of periodic re-readings on the same plots increases the precision of detecting changes in plant responses compared to intermittent single readings on separate plots. This is somewhat comparable to the use of paired plots in preference to random plots in experimental designing.

In order to determine the increased precision from the use of re-readings on the same transects compared to 2 readings on separate sets of random transect, comparable variances can be calculated. In the latter case, the variance for the original loop reading and the variance for the re-readings are averaged. This average variance can be compared to one-half the variance calculated from differences between the original loop readings and the re-readings.

In the present study, two separate random samples would require 3 times as many transects for each reading compared to re-readings on the same plot to detect changes in canopy cover with the same precision. In like manner, it would require from 8 to 10 times as many samples to detect changes in percent composition of the dominant species and twice as many to determine changes in surface ground cover.

In the present study, it required ⅓ longer to establish, read, relocate, and re-read a permanent transect compared to a single reading on two separate randomized transects. Therefore, 3 random transects could be read twice while 2 permanent transects are being read and re-read. This increased number of random transects compared to permanent transects does not compensate for the increased number required for equal sampling efficiency.

This would indicate that attempts to re-read the same transect would be desirable unless cost of materials for marking the trassect lines was exorbitant.

Sampling Efficiency

From the standpoint of time required to record the hits on a 100-foot transect, the point frame was considerably more rapid. After the line was stretched and ready for reading, the point frame required only 14 minutes, whereas the line loop and line point both required about 21 minutes.

Precision of sampling can be measured by the relative size of the standard deviation with respect to its mean or by the number of samples required to estimate means with the same precision and the same probability.

The line point transect had the

Table 4. Standard deviations averages and number of 100-foot transects required to measure vegetation and ground cover by the random line loop and the point frame transects with equal efficiency.[1]

	Line loop 100′ transect			Point frame 100′ transect		
Vegetation measurements	s	$\bar{x}$	No. of transects required	s	$\bar{x}$	No. of transects required
Percent canopy cover	9.89	56.2	12	5.85	70.7	3
Percent ground cover	6.97	87.9	3	6.08	90.2	2
Percent composition of major species	6.71	19.7	46	6.15	20.0	38
Percent composition of minor species	1.78	2.4	220	2.59	3.0	298

[1]Calculations for number of samples needed was based upon estimating the mean within 10 percent of the true mean with a 5 percent probability.

largest coefficient of variation for most measurements and therefore was consdired less precise than the point frame or the line loop. Data for precision of the line loop transects compared to the point frame transects are presented in Table 4. The number of 100-foot transects required to sample with the same precision was considerably higher for the random line lop transect than for random point frame transects for estimates of percent canopy cover, percent surface ground cover, and percent composition of the dominant major species. However, for estimates of the percent composition of minor forage species, the line loop transect required less transects than the point frame. This difference in favor of the line loop transect may be a result of chance since in neither method was the standard deviation considered an accurate estimate because of the low occurrence of these species along the 12 transect lines. In either case, it is indicated that minor species cannot be sampled adequately because of the large number of transects required. Even for major species, it requires from 38 to 46 100-foot transects selected at random to detect a change of 10 percent with a 5 percent probability.

Under conditions of this experiment, it would require about 16 hours to sample 38 one hundred-foot random transects with the point frame method and about 24.5 hours to sample 46 one hundred-foot random transects with the point loop method.

It is believed that either method would detect changes within vegetation classes or surface ground cover with equal precision if the calculated number of samples were taken in each case. If a change in vegetation involves replacement of grasses by shrubs, the line loop would overemphasize the change since the line loop as used in this study overestimates shrubs and underestimates grasses compared to either point method.

Summary and Conclusions

During the late summer of 1959, data were collected by the line point, line loop, and point frame transects on a mountain-brush type in northern Utah to determine the efficiency of each method in estimating canopy cover, surface ground cover, and species composition.

Twelve 100-foot transects were randomly located in an area 1300 by 500 feet. All methods were applied on each transect. Two recorders read the transects by the line loop and the line point methods.

The line point method gave a significantly higher canopy cover than the line loop method, but there was no significant difference between methods or between men for surface ground cover values. The point frame method likewise gave a significantly higher canopy cover than the line loop method, but the coefficient of variation for the point frame was considerably smaller than either the line point or the line loop methods.

The line loop method overestimated the percent canopy cover for shrubby species and underestimated it for grasses compared to the line point or the point frame methods.

All methods appeared to estimate the percent canopy cover for forbs about the same.

Use of the nearest plant measurement, where direct hits under the line were not recorded, indicated that there is likelihood of introducing bias.

Replacing the transect line to measure the accuracy of re-reading the same hits by the line loop method showed that canopy cover and surface ground cover were not significantly different from the original reading. However, only about 68 percent of the hits were identical species hits when the reset hits were compared to the original hits.

It is concluded that re-reading the same transects at intermittent periods is preferred to periodic random sampling because of increased precision. It is also concluded that the point frame transect is more precise and requires less time than the line loop or the line point.

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